incorporated-herein-by-reference co-owned U.S. Patent Application 08/729,390 describes the hardware of a base station of such a system in detail, the base station preferably having four antenna elements. In a second implementation, the subscriber units have fixed location. The PHS communications protocol again is used. Wireless systems with fixed locations are sometimes called *wireless local loop* (WLL) systems. A WLL base station into which some aspects of the present invention are incorporated is described in co-owned U.S. Patent Application 09/020,049 (filed February 6, 1998) entitled *POWER CONTROL WITH SIGNAL QUALITY ESTIMATION FOR SMART ANTENNA COMMUNICATION SYSTEMS*, Yun, Inventor, incorporated-herein-by-reference (hereinafter "Our Power Control Patent"). Such a WLL base station may have any number of antenna elements, and many of the simulations described herein will assume a 12-antenna array. It will be clear to those of ordinary skill in the art that the invention may be implemented in any SDMA system with one or more that one spatial channel(s) per conventional channel, and having mobile, fixed or a combination of mobile and fixed subscriber units. Such system may be analog or digital, and may use frequency division multiple access (FDMA), code division multiple access (CDMA), or time division multiple access (TDMA) techniques, the latter usually in combination with FDMA (TDMA/FDMA).

A1

• *Please replace the paragraph from page 13, line 24 to page 14, line 22, with the following:*

Figure 1 shows the transmit processing part of the transmit RF part of a base station (BS) on which the present invention may be embodied. Digital downlink signal 103 is to be broadcast by the base station, and typically is generated in the base station. Signal 103 is processed by a signal processor 105 which processes downlink signal 103, the processing including spatial

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processing comprised of weighting the downlink signal 103 in phase and amplitude into a set of weighted downlink antenna signals, the weighting describable by a complex valued weight vector. Signal processor 105 may include a programmable processor in the form of one or more digital signal processor devices (DSPs) or one or more general purpose microprocessors (MPUs) or both one or more MPUs and one or more DSPs together with all the necessary memory and logic to operate. The reader is referred to above-mentioned co-owned U.S. Patent Applications 08/729,390 and Our Power Control Patent for details. In the preferred embodiments, the spatial processing (spatial multiplexing) and the methods of the present invention are implemented in the form of programming instructions in a signal processor 105 that when loaded into memory and executed in the DSP(s) or MPU(s) or both cause the apparatus of Figure 1 to carry out the methods. Thus signal processor 105 has the same number of outputs, that number denoted by *m* herein, as there are antenna elements in the transmitting antenna array of the base station. The outputs are shown as 106.1, 106.2, ..., 106.*m* in Figure 1. In the preferred embodiment, the same antenna array is used for transmitting and for receiving with time domain duplexing (TDD) effected by transmit/receive switch. Since the invention mainly is concerned with transmitting, duplexing functionality is not shown in Figure 1. Figure 1 thus would apply also for a base station that only transmits, for a base station with different antennas for transmission and reception, and for a base station that uses frequency domain duplexing (FDD) with the same transmit and receive antennas. The *m* outputs of the signal processor 105, typically but not necessarily in baseband, are upconverted to the required RF frequency, then RF amplified and fed to each of the *m* antenna elements 109.1, 109.2, ..., 109.*m*. In the WLL and mobile systems on which the invention is implemented, some of the upconversion is carred out digitially, and some

in analog. Since upconversion and RF amplification is well known in the art, both are shown combined in Figure 1 as RF units 107.1, 107.2, ..., 107.*m*.

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• *Please replace the paragraph denoted by page 15, line 22 through page 16, line 25 with the following:*

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In another implementation, the signal processing procedure includes post-processing after the spatial processing, for example, using analog or digital filtering in baseband, or analog filtering in the RF domain, the spatial processing typically but not necessarily using essentially the same transmit weight vector for each repetition. In each of the *n* instances of transmitting the downlink signal, the downlink signal is spatially processed to a plurality of signals, one for each antenna element. Each of the antenna signals is post-processed in a different way. Note that each of the antenna signals is upconverted to RF, usually with one or more stages of intermediate frequency (IF) amplification, and the processing may be done before such up-conversion, using digital or analog means, or after digital upconversion (when there is digital upconversion) using digital or analog means, or after analog upconversion using analog means. In the analog implementation, different analog filtering is introduced in each of the *m* antenna signals, and in each of the *n* instances in RF units 107.1, 107.2, ..., 107.*m* feeding the *m* antenna elements 109.1, 109.2, ..., 109.*m*. This may be done, for example, by itnroducign a different amount of time delay in each of the *m* antenna signals, and in each of the *n* instances. Figure 2 shows post processing means 203.1, 203.2, ..., 203.*m* which, for example, are each time delay apparatuses which produce *m* different time delays. For each RF unit, the post processing means is seen at the input. However, it would be clear to those in the art that post-processing might occur within the RF unit, and not only in baseband. When such time delays are introduced, appropriate

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equalizers may be needed by receiving subscriber units, as would be clear to those of ordinary skill in the art. The post processing may be done also, for example, by introducing a different amount of frequency offset in each of the *m* antenna signals, an in each of the *n* instances. Figure 2 shows post-processing means 203.1, 203.2, …, 203.*m* which in this case are each frequency offset apparatuses which produce *m* different frequency offsets. The amounts of different frequency offset or different time delay to introduce in each of the *m* antenna signals would be insufficient to cause problems for the demodulators at the subscriber units but sufficient to orthogonalize the *m* antenna signals. A particular frequency-offset introducing post processing embodiment may be used in systems that use programmable upconverter/filters in the RF transmit apparatuses. Such a device is the Graychip, Inc. (Palo Alto, California) GC4114 quad digital upconverter/filter device which is used in the implementation of RF systems 107.1, 107.2, …, 107.*m* in the base station of the WLL system described in Our Power Control Patent. The GC4114 has phase offset (and gain) registers which may be used to introduce frequency offset into the signal.

<u>PENDING CLAIMS</u>

Please enter the following new claims:

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40. A method comprising:

developing a plurality of signal processing procedures; and

iteratively processing a signal through each of the plurality of developed signal processing procedures to generate a plurality of processed signals which, when sequentially transmitted through a coupled antenna array, generate a desired radiation level at a number of locations within a desired sector.